# CONSTRUCTED WETLANDS SYSTEM, TREATMENT APPARATUS AND METHOD

## FIELD OF THE INVENTION

This invention relates to a water treatment system, apparatus and method used in connection with treating water in pond, particularly a decorative landscape type pond.

## BACKGROUND OF THE INVENTION

The use of ponds as a decorative landscape feature is becoming increasingly popular. One of the desirable features of such a pond is the ability to view fish and plants therein, as well as a clean and attractive bottom. It is also desirable to provide an environmentally friendly system which may attract various animals and insects. Thus, clear water is a desirable feature. But the viewability can be hampered by cloudy water which in many cases is caused by excess algae buildup. This buildup may be the result of excess nutrients, such as total nitrogen and phosphorus, beyond acceptable levels which may be caused by animal waste products, fertilizer run off, chemical additions and the like.

Chemicals such as chlorine or copper based compounds can be added to the pond to control the nutrient level or to destroy the algae. But these chemicals could adversely impact the plants and fish, tend to break down rapidly, require repeated applications, may be expensive and may require extensive balancing to assure the proper water chemistry.

Thus, it is an object of this invention to control the clarity of decorative pond water without reliance on chemical additives.

Filtration systems, which may include a skimmer system, have been employed to remove leaves and other matter that may fall onto the pond surface. However, such

matter may fall to the pond bottom to form sediment or break up into particulate matter which may be suspended or also form sediment. These filters act to skim the surface matter and may remove some of the nutrients and particulate matter.

However, it is desirable to more effectively remove nutrients, particulate matter and sediment so as to enhance the viewability.

The use of natural processes of the type associated with wetlands, where aquatic plants utilize and/or remove nutrients is desirable. Various processes have been suggested by which these plants bioaccumulate and remove the nutrients that directly or indirectly degrade the water quality. Wetlands occur in nature and are used to cleanse lake and river water. Recently, constructed wetland features have come into use.

Thus, it is another object to employ a constructed wetlands feature with a decorative pond system to enhance viewability.

These and other objects will become apparent from the following description and appended claims.

## SUMMARY OF THE INVENTION

The system, apparatus and method of this invention meet the foregoing objects, enhance water clarity, reduce nutrient level, minimize the use of undesirable chemical additives, remove undesirable suspended and settled matter and employ the use of a constructed wetlands.

In this invention, there is a main body of water or decorative pond and a treatment or constructed wetlands pond. The ponds are usually separate, but may be sections or zones of a single body of water. The wetlands pond includes a treatment apparatus which (A) receives water from the main pond, (B) disburses received water into the treatment pond, and (C) collects particulate matter. The wetlands pond also includes:

facultative bacteria; a substrate (such as gravel) for the bacteria; vegetation or aquatic plants to utilize the nutrients and reduce the nutrient level; and a device for the return of treated water to the main pond usually by gravity. Such a device may be a waterfall feature.

The treatment apparatus includes (1) an elongated disbursement module that defines a passageway, a flat bottom, a water inlet end, an outlet end, and arcuate upper surface joined to the bottom with a series of exit apertures in the upper surface and (2) a hollow, cylindrical stack-like structure for use in cleaning a module which is coupled to the stack and the stack also includes a cap that sealingly engages the top of the stack.

Water from the main or decorative pond is pumped to the inlet end of the disbursement module and flows through the disbursement module. Due to gravity, pressure and velocity differences, particulate matter in the water will fall to the flat bottom. The remaining water exits the disbursement module through exit apertures in the module where it flows into the wetlands pond and the bacteria, substrate and vegetation act to reduce the nutrient level in the water. The sedimented and reduced nutrient level water may be returned to the main pond by an overflow or waterfall system that may add oxygen to or oxygenate the water. The treatment system and apparatus are operated continuously so as to continuously reduce sediment and nutrient levels.

Periodically the system is cleaned via the stack. When the cap on the stack is removed, water flows to the bottom of the stack with sediment therein which collects on stack bottom. Thus, by scooping, vacuuming or pumping techniques, sediment at the bottom of the stack can be removed.

Several different treatment configurations can be assembled by adding additional treatment modules or the stack. These configurations can include a cross like

configuration useful in a large pond.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a view showing the decorative pond, the treatment pond with the treatment apparatus therein, and water being pumped from the decorative pond to the treatment pond;

Figure 2 is a sectional view along line 2-2 of Figure 1 and showing (on one side) the interior of the pond with part of the pond shown filled with gravel and (on the other side for illustrative purposes) the other part of the pond not completely filled with gravel;

Figure 3 is an enlarged view taken from Figure 2 showing the disbursement module in cross section;

Figure 4 is an elevational view of the treatment apparatus showing the stack and disbursement module;

Figure 5 is a sectional view taken along line 5-5 of Figure 4 showing the stack in cross section and the upper surface of the disbursement module;

Figure 6 is a sectional view taken along line 6-6 of Figure 5 showing the outlet end of a disbursement module coupled to the stack;

Figure 7 is a plan or top view of a disbursement module showing the upper surface thereof;

Figure 8 is a side or elevational view of a disbursement module as in Figure 7;

Figure 9 is a side or elevational view of the stack showing the stack and cover therefore;

Figure 10 is a top view of the stack without the cover;

Figure 11 is a view taken along line 11-11 of Figure 8 showing the outlet end of

the disbursement module;

Figure 12 is a view taken along line 12-12 of Figure 9 showing a coupling portion of the stack constructed to couple to the outlet end of the disbursement module;

Figure 13 is a view taken along line 13-13 of Figure 8 showing the inlet end of the disbursement module;

Figure 14 is a vertical sectional view taken along line 14-14 of Figure 8 showing an aperture web section and exit apertures;

Figure 15 is a sectional view taken along line 15-15 of Figure 8 showing a rib construction for the disbursement module;

Figure 16 is an elevational view showing the stack and disbursement modules in a cross like configuration;

Figure 17 is a perspective like view showing a stack and disbursement modules at right angles with one module and extender is solid line and the other in broken line;

Figure 18 is an elevational view showing a conduit coupled to a disbursement module with the flow therethrough; and

Figure 19 is a section view of a single pond that includes both a decorative zone and a treatment zone.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

There is disclosed herein a pond system 10 generally which includes a main or decorative pond 12 generally and a treatment or wetlands pond 14 generally.

The main or decorative pond is formed by a large (i.e. fractional or multi-acre) excavated recess which forms a bottom 16 and sides 18. A water impermeable liner 20 is positioned in the recess against the bottom 16 and sides 18. The liner 20 is intended to

minimize water loss from the pond to the adjacent ground. If needed, the liner can be plastic, rubber, clay, concrete or the like.

A submersible pump 22 positioned in the decorative pond 12 connects to the conduit 24 and directs flow from the decorative pond 12 to the treatment pond 14. The conduit 24 is usually about 3.5 inches in diameter. It is understood that the pump is in a protective housing to minimize clogging while permitting water flow to the pump. As an alternative, there can be used an in-line above ground pump to draw water from the decorative pond and discharge to the wetlands pond.

The decorative pond is filled with water which can be stocked with fish, and appropriate decorative vegetation. One of the desirable attributes of decorative ponds such as 12 is the viewability of the pond and its contents and thus the clarity of the water therein.

Algae may grow in the pond but if the growth becomes excessive the algae can cause the water to become cloudy or less clear and even cause the pond to turn to an undesirable color. Algae growth relates to the nutrient (e.g. total nitrogen and phosphorus) level in the pond and in turn from animal waste products, fertilizer run off, chemical additions etc.

Moreover, leaves or other objects that fall into the pond can settle to the bottom or can break up and form particles that are either suspended in the water or collect on the bottom.

In the wetlands pond 14 there is provided a treatment apparatus 30 generally which includes a horizontally positioned disbursement module 32 that is connected to the conduit 24. The treatment apparatus 30 also includes a vertical stack 33 that is closed at the top by a cap 34 and is positioned to extend from the pond bottom to above the top surface. The pond also includes a substrate for the growth of desirable bacteria, usually a gravel bed 36 which substantially fills the pond 14, as shown in Figure 2. Aquatic vegetation 38 is shown

growing on the top of the pond. For ease of illustration, Figure 2 shows the pond entirely filled with gravel, vegetation and water on the left hand side 36a, while only a small portion of the gravel bed 36 and vegetation are shown on the right hand side 36b. It will be understood that the pond is entirely filled with gravel, vegetation and water. Nutrient level reducing facultative bacteria adheres to the gravel and thus is in contact with the water to be treated. The gravel provides a base or supportive substrate for the bacteria, but other materials can be used.

It will be understood that water is drawn from the decorative pond 12 by the pump 22, directed to the treatment pond through the conduit 24 and disbursed into the module 32. The particulate matter separates by gravity and the remaining water then flows from the disbursement module into the gravel, the water thereinabove, and is in contact with the bacteria and the vegetation. The water is thus treated to reduce sediment and reduce nutrient level. Treated water then flows from the treatment pond 14 perhaps via the waterfall feature, such as 40, to the main pond 12.

The wetlands pond 14 is usually smaller than the landscape pond, perhaps about 5% of the area, and may be 15 feet or more in diameter and 18 inches to 24 inches deep. Also, the wetlands pond is excavated and includes a sloping bottom and a trough 42, or channel like construction, centered in the bottom of the wetlands pond. Moreover, the wetlands pond may be above the landscape pond, as shown, or at a similar height as the landscape pond.

A liner 44 (such as plastic, rubber, concrete or clay) is positioned in the wetlands pond against the sides, bottom and trough. The treatment assembly 30 and particularly the disbursement module 32 is positioned in the trough and defines an elongated flow passageway, sediment collector and water exit apertures. The module 32 is coupled at its inlet end 46 to the smaller diameter conduit 24 from the pump 22. There is a substantial

difference in the cross sectional size and shape (i.e. geometry) of the disbursement module 32 and the conduit 24. Thus, water flows from a small conduit to a large passageway and results in a substantial pressure drop and decreases in velocity, between the conduit 24 and module 32. The module 32 as seen in Figure 3, has a flat bottom 48 and curved or arcuate upper portion 50 that is joined to the flat bottom. The arcuate portion 50 defines water exit apertures such as 52 and 54. The bottom 48 of the module 32 rests in the trough 42 and couples to the base of the stack 33.

In general the operation of the system 10 can be described as follows. Water is drawn from the pond 12 by the pump 22. The water is pumped via conduit 24 to the disbursement module inlet end 46. Due to the changes from the conduit 24 to the disbursement module 32 water passing from the conduit to the module experiences a drop in pressure and a drop in velocity. This allows particulate matter to separate from the water and be drawn by gravity to and collect on the flat bottom 48. The water, from which the sediment has been deposited, flows from the disbursement module 32 through the exit apertures 52 and 54 into the treatment pond 14. There water flows through a gravel bed 36 and is exposed to the facultative bacteria and nutrient level reducing aquatic vegetation 38. The action of the gravel, bacteria and vegetation reduce the nutrient level in the water. Then the water which has a reduced nutrient level and reduced sediment level is returned to the landscape pond via the waterfall feature 40, which can add oxygen to or oxygenate the water. As opposed to the original or untreated water, the returned or treated water has reduced sediment content, reduced nutrient level and may have an increased oxygen content. Continued treatment cooperates in maintaining clarity of the water in the decorative pond by reducing nutrient levels and thus algae growth.

Referring now to Figure 2, the disbursement module 32 is shown in the trough 42

in the bottom of the wetland pond 14. The disbursement module is positioned in, but rests slightly above the trough bottom and at a small angle. This is because the stack 33 includes a base/connector portion 51, is resting on the bottom 53 of the trough 42 and is slightly below the disbursement module 32. The trough is at a slight angle, so as to assure a slight downward slope to the disbursement module 32. The stack base/connector 51 includes a port or coupling opening such as 55 that is constructed to receive an end of the disbursement module 32 and couple thereto as shown in Figure 6. The stack base/portion 51 is positioned on the bottom 53 so that sediment in the disbursement module such as 32 can be washed into the stack base/connector for removal.

As seen in Figure 2, the gravel bed includes large gravel (4" to 6" in diameter) on the bottom, medium gravel (1 1/2 to 2" in size) resting on the large gravel and pea gravel (1/2" in diameter) on the medium gravel. This gravel fills the treatment pond 14 and covers the disbursement module 32. Rather than gravel, other biological media such as coconut fiber plastic ribbon, can be used as the substrate for the bacteria.

A typical module 32 is seen in Figures 7 and 8. It includes an inlet end 46 and outlet end 56, is elongated and between the inlet and outlet ends, includes a plurality of ribs such as 58, 60 and 62 and a plurality of aperture web sections such as 64 and 66 which include exit apertures 64a, 64b, 66a and 66b. The inlet end 46 is provided with a short conduit stub 68 that is adapted to be connected to the conduit 24. The inlet end of the disbursement module 32 also includes an end wall 70 which closes the end except for the opening made by the conduit stub 68. Thus, water entering the disbursement module 32 by the conduit stub 68 experiences a drop in velocity and a drop in pressure which permits a separation of sediment and particulate matter. Each of the pressure drop and the velocity drop are on the order of 92.5%. Water continues to flow through the passage way and exits the

disbursement module via the apertures such as 64a, 64b, 66a and 66b. The other end of the disbursement module includes an outlet end which does not have a wall and is open. The outlet end is sized to engage a coupling on the stack 33. The bottom 48, the inlet end 46, the outlet end 56, the ribs 58, 60 and 62, and the aperture web sections 64 and 66 are seen in Figure 8.

The stack 33 is seen Figures 9 and 10 and a top cap 34 is seen in Figure 9. The stack includes a plurality of couplings such as 55, 72, 74 and 76 spaced about the stack periphery as seen in Figure 10. A disbursement module couples to the stack by the outlet end 56 fitting over and sealing against the stack coupling 72. The outlet end 56 is slightly larger than the stack coupling 72. The stack base or lower portion 51 is square and includes the couplings. The upper portion 78 is cylindrical and extends above the pond surface. The cap 34 sealingly engages the top of the stack and is removed for cleaning and removal of sediment. When the cap is removed, air pressure inside and outside the stack equalizes, water flows from the disbursement module into the stack bottom and sediment collects on the stack bottom. From there the sediment can be scooped out or removed by a pump etc.

Referring now to Figure 11, the outlet end 56 is seen and can be characterized as a female end which is about 10 1/25" high and 12" wide. That female end connects as seen to the male portion of the stack coupling 72.

Referring now to Figure 13, the inlet end 46 is shown with the conduit stub 68 and end wall 70.

The rib construction, such as 62, is shown in Figure 15 and the aperture web construction 80 is seen in Figure 14. A pair of water flow apertures 82 and 84 are seen in the construction.

A cross shaped apparatus is shown in Figure 16 where there are provided at least four

(4) disbursement modules 90, 92, 94 and 96 connected to the stack 98. In broken line additional modules such as 100, 102, 104 and 106 are shown attached to the end of the modules 90, 92, 94 and 96. A cross shaped system such as this can be used where the decorative pond is very large and the treatment pond is relatively large.

Another form of the apparatus is shown in Figure 17. There the stack 106 is shown for connection to the disbursement module 108. In this situation, the disbursement module's inlet end 110 has been cut so as to remove its end wall and connector stub. A second module 112 is fitted to the first module 108 and the additional module 112 has an outlet 114 which fits over and grasps the inlet end 110 of the dispersion module 108. The inlet end of the second module is shown and includes the conduit stub 116 and end wall 118. In broken line two (2) other disbursement modules 120 and 122 are shown and suggest that the modules can be formed in an L or right angular shape. It is to be understood that in the stack of Figure 17 couplings such as 124 which are not used are closed off by a wall and there is no flow through those couplings.

The operation of the system and the wetlands pond has been discussed hereinbefore. However, it is desirable to periodically maintain the system by removing sediment that may build up in the stack or disbursement modules. In that case, the cover is removed 34 and water is permitted to flow into the stack and wash sediment into the stack from the modules as suggested in Figure 6. The sediment in the base of the stack is then removed by scooping or vacuuming. It has been found that a wetlands system which employs the treatment system of this invention to cleanse the water cooperates with the main pond in maximizing clarity and low nutrient level of the water in the main pond.

In a one module system such as shown in Figure 1, 5, 6, 7, 8 & 18 the water in the conduit 24 flows at about 3,600 gallons per hour (gph). If additional modules are used, the

flow rate is increased by 3,600 gph for each additional module. The area of the exit apertures from each module is sized to assure that quantity of water that exits the module is about the same as enters the module. Thus, there is about 1.1 ratio between entering volume and exiting volume. Because of the significant change in geometry and size from the conduit to the module the water velocity and pressure drops significantly. This permits particulate matter in the water to separate and precipitate to the module bottom. The remaining water can flow from the exits apertures.

The decorative and wetlands ponds can be separate but at the same height. As shown in Fig. 19, a single pond 150 can have a decorative zone 152 and a separate but unitary wetlands zone 154 which includes a treatment apparatus, gravel, facultative bacteria and an aquatic vegetation as described before.

Other and numerous changes and modifications can be made to the embodiments disclosed herein without departing from the spirit and scope of this invention.

What is claimed and desired to be secured by letters patent is: